PENSACOLA BAY BRIDGE
REPLACEMENT PROJECT

Popsicle Stick Bridge
Lesson Plan – Unit IV

TRUSS BRIDGE

Objective: "Truss Bridge." After this lesson and watching a video, students should be able to:

- discuss truss bridge designs;
- hypothesize the effectiveness of truss bridges made of popsicle sticks; and
- discuss findings regarding the effectiveness of truss bridges.

Summary: A truss bridge is a bridge whose load-bearing superstructure is composed of trusses—a structure of connected elements that usually form triangular units. Through a video presentation, students will learn about truss bridges and how they manage the natural forces of compression and tension. Truss bridges are constructed by connecting a framework of triangles, and the trusses themselves are special to engineers because of the way they work to distribute weight.

Trusses do not alter when they encounter outside forces, because the triangle shape spreads the force evenly over each of the sides. Truss bridges come in many different styles and are effective at holding more weight over longer distances.

ACADEMIC STANDARDS

Objectives:

SC.6.P.13.1

Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.

SC.6.P.13.2

Explore the Law of Gravity by recognizing that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.

SC.7.P.11.2

Investigate and describe the transformation of energy from one form to another.

SC.7.P.11.3

Cite evidence to explain that energy cannot be created nor destroyed, only changed from one form to another.

SC.8.N.1.1

Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

SC.8.N.1.5

Analyze the methods used to develop a scientific explanation as seen in different fields of science.

SC.8.N.1.6

Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence.

s. 1003.41, Florida Statutes
Rule 6A-1.09441, F.A.C

Materials: PowerPoint presentation or slides showing the different Truss designs

YouTube video “The Strongest Shape”   https://www.youtube.com/watch?v=Vqspp8MG1m0

Each group needs:

- Pencil and paper
- 20–25 popsicle sticks per student (the number of sticks will vary depending on the selection of the triangle design)
- Craft scissors, to cut popsicle sticks
- Craft glue or glue sticks

OR

- Toothpicks
- Miniature marshmallows

Vocabulary:

Beam: Thin, horizontal members of the bridge that support the deck.

Compression: A pushing force that tends to shorten objects, or the application of power, pressure, or exertion against an object that causes it to become squeezed, squashed, or compacted.

Deck: A slab of concrete or steel that rests on the floor support system and is supported by beams. Traffic moves on the deck.

Girders: A type of beam. Refer to the ‘beam’ definition.

Tension: A pulling or stretching force that tends to lengthen objects.

Truss: Jointed open structure; the frame is divided into a series of triangular figures for rigidity and strength.

Procedure:

Activity One[1]:

Tell the students that it is important that they carefully follow these instructions. In groups of 3–4 students, each group should select one of the eight typical truss configurations.

1. Give each group a chance to select a typical truss configuration. Verify that all configurations have been selected and that no more than three groups have chosen the same configuration.
2. Have each student determine how they will connect their popsicle sticks for the sides.
3. Tell the students: (Now that your group has determined which of the typical configurations you would like to investigate, I need you to discuss how you will build it. The configuration that you have selected will form the sides of your truss. Next, you need to determine how each member of your group will construct the sides. There are different ways to join the popsicle sticks or toothpicks and marshmallows based on the pictures shown. Each member of each team should choose a unique way to join the truss members while building the same truss as the rest of the group.)

[1] Source: https://www.teachengineering.org/activities/view/cub_trusses_lesson01_activity1

Activity Two:

To have a visual understanding of the different types, students will engage in activities identifying the types and exploring the truss bridges around the world using the selected websites.

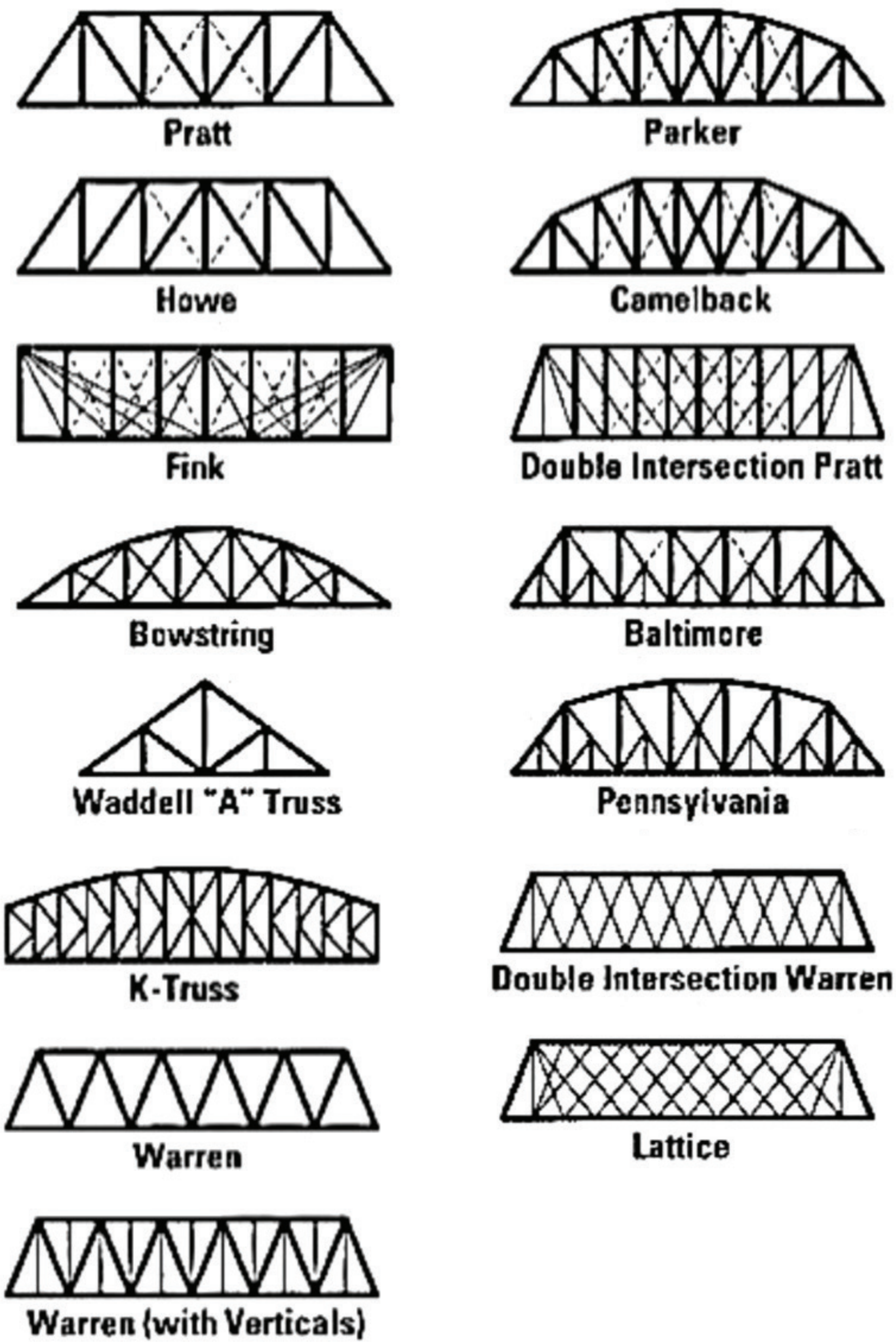
Using the links provided on the Activity 2 worksheet, find the types of truss bridges around the world (refer to Activity #2 — Sheet 2), and give the type, location, and length (span) of the bridge.

ACTIVITY # 1

Build the Bridges

Below are the different types of truss bridges. Students are to use this sheet to complete Activity 2.

http://historicbridges.org



ACTIVITY # 2

Find the Truss Bridges

Using the http://historicbridges.org website, find examples of truss bridges listed below.

For example search for "Pennsylvania Truss."

Type	Name	Location	Length (Span)
Pennsylvania			
Baltimore			
Lattice			
Bowstring			
Warren			
Pratt			
Howe			

TEACHER BACKGROUND INFORMATION

Truss Bridge Design - The Basics

To expand on the beam design and to strengthen its ability to cope with the forces exerted on it, thereby enabling greater spans, designers added latticework sides or trusses to the beam, creating the truss bridge. The truss form and shape is essentially a large beam made up of individual pieces; the top and bottom of the truss are called chords, with the vertical and diagonal members connecting the top and bottom chords. The compression or tension in the truss members supports the loads from the bridge deck and the traffic moving on it. The truss bridge gets its rigidity as a function of its height. It is much stiffer than a typical beam, because it is much taller than a typical beam. However, even with its added ability to dissipate force and its increased rigidity, a truss bridge still has span limitations, and eventually designers will reach the limits of the design. This means that, for longer spans, something else is needed.

The History of Truss Bridges

Before the Industrial revolution (19th century), almost all bridges in use were made of stone. But wood and iron can resist tension and compression better than stone. The United States had plenty of wood, so they made many wooden bridges in those times; most of them were truss bridges. Town's lattice truss, a very simple variant of truss, was patented in 1820. The first half of the 19th century saw very few truss bridges made of iron, although the first patent for an iron truss bridge was issued to Squire Whipple in 1841. But metal slowly started to replace wood, and wrought iron bridges started appearing in the U.S. in the 1870s, only to be replaced by steel ones in the 1880s and 1890s. In time, some places (such as Pennsylvania) continued building truss bridges for long spans well into 1930s, while others (such as Michigan) started building standard-plan concrete girder-and-beam bridges.

From the time of the first truss bridge, engineers experimented with different forms, trying to find better shapes and the one that would suit them for the particular problems that they faced. Because of that, we have, today, many forms of truss bridges. A truss bridge can have a deck (roadbed) on top (deck truss), in the middle (through truss), or at the bottom of the truss. If the sides of the truss extend above the roadbed but are not connected, it is called a pony truss or a half-through truss.

Common Types of Truss Bridges:

Allan truss: a pony truss; based on the Howe truss. The first Allan truss was finished on August 13, 1894.

Bailey truss: made for the military; it can be easily combined in various configurations.

Baltimore truss: made like the Pratt truss, but it has additional bracing in the lower section of the truss which prevents buckling in the compression members.

Bollman truss: an all-metal truss with many independent tension elements, which makes for a strong bridge that is easy to assemble.

TEACHER BACKGROUND INFORMATION CONTINUED

Burr arch truss: a combination of an arch and a truss, which forms a strong and rigid bridge.

Howe truss: has vertical elements and diagonals that slope up toward the center of the bridge.

K truss: has one vertical member and two oblique members in each panel (which form a letter "K").

Lenticular truss: uses a lens-shape truss which has an upper and lower curve and diagonal elements between them. If the curves are above and below the roadbed it is a "lenticular pony truss".

Long truss: a variant of the Howe truss, but made of wood and used for covered bridges.

Parker truss: a variant of the Pratt truss that has a polygonal upper chord. If the chord has exactly five segments, it is called a camelback.

Pegram truss: has chords that are wider at the bottom but of the same length as each other at the top.

Pratt truss: has vertical members and diagonals that slope downward to the center. It is a variant commonly used for railroad bridges.

Vierendeel truss: has members that are not triangular but rectangular. Rare are bridges made in this variant of truss, because it is not cheap.

Warren truss: has longitudinal members joined only by angled cross-members. They form equilateral triangles. It is a relatively light but strong and economical truss.

The History of Bridges and the Common Types of Truss Bridges excerpt from http://www.historyofbridges.com/facts-about-bridges/truss-bridge/

ASSESSMENT UNIT 4

Students will explore why trusses are used in bridges to add strength and stability. Truss bridges are constructed by connecting a framework of triangles. Trusses are a key engineering concept because they do not change when force is applied. The triangular shapes help to spread force around the three sides. Students will work to construct model trusses and then test them to evaluate the relative strengths of different truss configurations and construction styles. Each student group will use popsicle sticks and craft glue or hot glue or toothpicks and marshmallows to build a different truss configuration from a provided diagram of truss styles.